Technical Paper 374

(13) LEVEL II

SIMULATING VARIOUS MOON ILLUMINATION LEVELS WITH LIGHT-ATTENUATING DEVICES (LADS)

Paul R. Bleda

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER
Technical Paper 374

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)
SIMULATING VARIOUS MOON ILLUMINATION LEVELS WITH LIGHT-ATTENUATING DEVICES (LADs)

5. TYPE OF REPORT & PERIOD COVERED
--

6. PERFORMING ORG. REPORT NUMBER
--

7. AUTHOR(s)
Paul R. Bleda

8. CONTRACT OR GRANT NUMBER(s)
--

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Army Research Institute for the Behavioral and Social Sciences
5001 Eisenhower Ave., Alexandria, VA 22333

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
2Q162722A765

11. CONTROLLING OFFICE NAME AND ADDRESS
Deputy Chief of Staff for Personnel
Washington, DC 20310

12. REPORT DATE
Jul[redacted]79

13. NUMBER OF PAGES
14

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)
--
ARI-TP-374

15. SECURITY CLASS. (of this report)
Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)
Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)
--

18. SUPPLEMENTARY NOTES
--

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Light-attenuating devices	Continuous operations
Simulated darkness	Welder's goggle facemask
Night training	Bidensity filters
Rifle marksmanship	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

To reduce the problems of safety, logistics, and evaluation inherent in training at night, the Army Research Institute has developed experimental light-attenuating devices (LADs) that simulate night visual conditions during the day. Single-density or bidensity lenses can be fitted to existing face-masks and used to conduct certain night training operations during the day with little reduction in effectiveness.

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408 010

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20.

LADs were used experimentally in training and testing night rifle marksmanship during basic Army training at Fort Jackson, S.C. Filter densities effectively approximated night illumination with a full moon, a quarter moon, and a new moon; trainees using LADs performed as well as trainees performing under actual night conditions.

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Technical Paper 374

SIMULATING VARIOUS MOON ILLUMINATION LEVELS WITH LIGHT-ATTENUATING DEVICES (LADS)

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Office, Deputy Chief of Staff for Personnel
Department of the Army

July 1979

Army Project Number
2Q162722A765

Training and Evaluation

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FOREWORD

Since 1973, the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) has been investigating the concept of using simulated darkness for night training during daylight. Light-attenuating devices (LADs) that reproduce the essential features of night feasibility have been developed.

Three types of LADs have been developed on an experimental basis: a filter to fit on a standard Army sun/wind/dust goggle, used in research in nap-of-the-earth flight at Fort Rucker, Ala., in 1974; outsert lenses to fit over the M17 protective mask, used for land navigation research at Fort Lewis, Wash., early in 1977; and insert lenses to fit a conventional welder's goggle, as described in this report.

This report documents a field experimental evaluation of LADs as applied to training and testing night rifle marksmanship. The evaluation was conducted by the Basic Training Committee Group at Fort Jackson, S.C., in 1977 and 1978.

The LADs project has been accomplished jointly by ARI and Gentex Corporation (Omnitech Division) under contracts DAHC19-77-M-0077, monitored by J. Douglas Dressel, and DAHC19-77-M-0049, monitored by Paul R. Bleda. Work was done by the Human Factors in Tactical Operations Technical Area under the direction of Aaron Hyman, in response to the objectives of Army Project 2Q162722A765.

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Technical Director

SIMULATING VARIOUS MOON ILLUMINATION LEVELS WITH LIGHT-ATTENUATING DEVICES (LADs)

BRIEF

Requirement:

To investigate whether use of light-attenuating devices (LADs) could permit night rifle marksmanship training to be conducted during the day, and specifically to determine how well the LADs filters could simulate illumination levels from different phases of the moon as judged by their effect on marksmanship performance.

Procedure:

Prototype LADs goggles used lens filters of varying densities fitted in a welder's goggle facemask. The different optical filters reduced daylight to the perceived amounts of light given by the new moon, quarter moon, and full moon.

Soldiers learning night rifle marksmanship in Basic Training at Fort Jackson, S.C., were divided into three groups. One group was trained and tested during the day, wearing LADs goggles. The other two groups were trained and tested at night during the three phases of the moon, one by moonlight alone and the other with targets illuminated briefly by intermittant flashes of light. About a fourth of the 1,556 trainees were women.

Results:

Trainees using the prototype LADs performed as well as those training and testing du[illegible] actual night.

Qualifying scores fired with either LADs or during actual night were essentially the same for full and quarter moon illumination, noticeably poorer under new moon illumination alone. Flashes of light behind the targets enabled trainees to do equally well under all lighting conditions. Men qualified with higher scores than women regardless of illumination.

Both male and female soldiers using LADs fired fewer rounds to qualify, on the average, than soldiers during actual night.

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Utilization of Findings:

LADs can potentially enable many night training exercises to be conducted during the day, alleviating problems of scheduling, logistics, and safety. The lenses tested appear able to reproduce different levels of moonlight illumination for night rifle marksmanship training. Their use could save a great deal of training time and ammunition.

SIMULATING VARIOUS MOON ILLUMINATION LEVELS WITH LIGHT-ATTENUATING DEVICES (LADs)

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SIMULATING VARIOUS MOON ILLUMINATION LEVELS
WITH LIGHT-ATTENUATING DEVICES (LADs)

INTRODUCTION

Military personnel must be trained to rely on reduced visual cues when performing combat tasks during darkness. The conduct of field exercises at night, however, poses numerous problems relating to safety, logistics, and performance evaluation. To circumvent the problems inherent in night training, the Army Research Institute (ARI) has developed light-attenuating devices (LADs) that provide the essential features of night visibility during daylight (Farrell, 1975). The LADs are worn over the eyes and simulate night darkness by reducing the amount of illumination available to users. The level of reduced illumination can be changed to correspond to different phases of the moon.

The use of simulated night illumination for training has been evaluated with three prototype versions of the LADs. These versions have been fabricated with filters that attach as (a) a sandwich on the standard Army sun/wind/dust goggle, (b) outsert lenses on the M17 protective mask, and (c) inserts in a conventional welder's goggle.

The sandwich version was field tested for infantry tasks such as distance estimation, target detection, and terrain walking and also for nap-of-the-earth helicopter maneuvers (360° and 45° bank turns, hovering, obstacle avoidance and detection, etc.). Because performances with the LADs appeared to be degraded in the same way as performances at night, results of the field tests were encouraging.

Outsert lenses that fit on the M17 protective mask were field tested for navigation tasks. A bidensity lens with less attenuation in the lower portion than in the upper portion was used for safety reasons; navigators walking on rough terrain could verify their footing more easily. The results indicated that, compared to daylight, actual night performances degraded significantly in terms of navigation speed and accuracy. Performances obtained with the LADs were intermediate to those found in daylight and at night. It appeared that the bidensity feature allowed navigators using LADs to travel faster than navigators who performed at night (Peters et al., 1978).

The welder's goggle version of the LADs was developed in response to a field request from a basic training (BT) center in the Army. The BT center sometimes faced administrative problems due to scheduling anomalies (for example, paydays, holidays) that made it necessary to conduct night rifle marksmanship training on a given night with more than one company. When two companies underwent training on the same night, the night-fire range was required to operate for extended periods, creating hardships for both trainees and cadre.

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The advantage of the welder's goggle facemask was that it could be used by trainees who wore helmets and corrective lenses. The welder's shade plates (lenses) were made of polycarbonate plastic filters that contained an organic dye; one pair of the lenses had a metallic gold coating to filter out potentially harmful infrared and ultraviolet rays. Because the compartment holding the filters could be disassembled easily or removed intact, different filter combinations to produce different optical densities could readily be obtained or interchanged. Table 1 shows the technical specifications of welder's goggle LADs.

A potential limitation of the welder's goggle LAD is that the facemask restricts the user's field of view to about 50°; normal day or night vision is about 170°. This characteristic raises a number of issues, such as the extent to which a relatively narrow field of view limits depth perception, which in turn might reduce rifle-fire accuracy. This type of concern was not addressed directly in the research, because the immediate goal was not to specify the nature of the relationship between field of view and rifle-fire accuracy; rather, the main objective was to validate the behavioral correspondence between the various simulated and actual moonlight illumination levels in terms of their impact on marksmanship performance.

Levels of simulated darkness were produced with optical filters that attenuated the existing daylight by $10^{-5.3}$, $10^{-5.0}$, or $10^{-4.5}$ order of magnitude. Since the luminance level of a bright earth day is about 10^{3} foot-candles (a standard measure of illumination), the percentage of apparent light for these LAD wearers was 0.005, 0.01, or 0.03, respectively. These percentages correspond closely to actual physical measurements of night illumination levels during the new, quarter, and full moon phases (Van Cott & Kinkade, 1972).

It was predicted that performances obtained with the various densities of the LADs would not differ from performances during the corresponding phases of the moon. That is, the night rifle-fire accuracy found during daylight with the 5.3, 5.0, and 4.5 optical density filters would approximate accuracy obtained at night during the new, quarter, and full moon phases, respectively. It was anticipated, however, that performance would fall off as a linear function of the degree of darkness.

METHOD

Design

The overall design of the experiment was a 2 x 3 x 3 between-groups factorial. The factors were (a) sex of trainee, (b) level of illumination, and (c) type of darkness attenuation. The illumination level varied the degrees of simulated darkness to correspond to the new, quarter, and full moon phases. The type of darkness factor included one experimental

Table 1

Welder's Goggle Version of LADs

Characteristics of filter	Characteristics of facemask	Limitations
Standard welder's #12 or #13 molded shade plate lens made of organically dyed polycarbonate plastic	Commercial welder's goggle facemask (American Optics product #488) made of soft green vinyl material	Restricted field of view
Evaporated hard metallic (gold alloy) coating on one side of the plate to filter out potentially harmful infrared and ultraviolet light	Indirect ventilation through plastic louvers that eliminate light leakage by creating light traps	Not completely light-tight
Acetate sheet shade lens with tinted gray base	Lens compartment can be easily disassembled or removed for exchange of filter combinations	Uncomfortable for some users with relatively small head sizes
Clear cover plate made of polycarbonate plastic with scratch-resistant coating	Foam urethene pads have been added as temple flaps and along the edges that come in contact with the cheekbones, forehead, and nose to increase light tightness. Composition gasket of trenolic-impregnated fiber and plastic serves as seal between facepiece and frame. Metal spring separates lens	
Hydrosorb coating to reduce fogging on inside of lens		

group in which trainees performed with LADs during daylight (simulated darkness) and two control conditions that involved actual night illumination.

One of the two control groups was exposed to targets with flashing lights that showed the target silhouette, while the other fired without such visual cues. The flashing-lights condition was included because it reflected the standard operating procedure at the installation where the field test was conducted. The two primary dependent measures were the percentage of trainees who qualified for record by passing the qualification test and the number of rounds of ammunition fired.

Subjects

The participants were selected from 15 integrated training companies that underwent the night rifle marksmanship portion of BT at Fort Jackson, S.C., in December 1977. Five companies were arbitrarily assigned to the various moon phases. About 75% of the 1,556 trainees participating in the field test were males.

Equipment

The night-fire range was equipped with a Disappearing Automatic Retaliatory Target System (DARTS) that allowed automatic recording of the exact number of hits scored by trainees. This system featured two banks of targets located at distances of 25 m and 50 m with 30 "E"-type silhouette targets on each bank. The targets were roughly the size of a man's head and torso. Each trainee was exposed to 20 targets: 10 at each of the two banks for every phase of the training program. Ancillary DARTS equipment included target silhouette illumination devices and variably timed "enemy" muzzle flashes. A prepunched tape permitted full automatic control of the range, including the electronic recording of each hit or miss.

Procedure

When they arrived at the night-fire range, trainees already had completed the day portion of the Basic Rifle Marksmanship (BRM) program. The night segment involved 6 hours of instruction, practice, and testing. The segment began with a 45-minute bleacher presentation that included a walk-through demonstration of the entire night program. Following this presentation, each company of about 100 trainees was divided into five fire orders of about 20 trainees each, who were assigned individually to the firing points on the range.

All firing was performed with the M16A1 rifle, the standard military weapon used by riflemen in infantry squads. Preloaded magazines containing the appropriate number of rounds to be fired in the semiautomatic mode were issued to each trainee.

The M16A1 has a rear sight with an aperture of only 2 mm; one cannot see through it during darkness to align (or point) the front post sight onto the target. Consequently, trainees are taught a special night-fire technique that does not use the sights for firing during darkness. This technique differs from its day counterparts in two ways. First, the marksman raises his or her head so that the chin rests on the gun butt, not against its side. Second, both eyes (not just one) remain open when the weapon is sighted; this is done by aligning the end of the barrel onto the target rather than by coordinating the front and rear sights.

Practice Fire. Each trainee initially fired 32 rounds using the night rifle-fire technique during daylight. After completion of the day phase, trainees fired an additional 40 practice rounds in either simulated or actual darkness. All research groups received identical instructions, except that trainees wearing the 5.3, 5.0, or 4.5 LAD filters performed their practice and testing during daylight. For the two control groups, these activities were conducted at night either with or without flashing lights that illuminated the target silhouette. Trainees assigned to the LADs condition were allowed 30 minutes for dark adaptation while those in the control groups waited for darkness.

Record Fire. Trainees were issued 60 rounds of ammunition for the test phase of the night BRN program. Current requirements for qualification at Fort Jackson stipulate 10 hits out of the 20 target exposures with at least 3 hits recorded against 50-m targets. In addition to qualifications, the number of hits obtained at the 25-m and 50-m targets and the number of rounds expended were also determined.

RESULTS

Table 2 shows mean performances along each of the five relevant dimensions. The pattern of results for the percentage of qualifications also was found for three of the remaining measures (i.e., hits at 25 m and 50 m and total hits), and differed only for the number of rounds fired. In view of this pattern, results are given only for the qualifications and rounds fired.

Qualifications

Sex of Trainee. A 2 x 3 x 3 weighted-means analysis of variance was performed on the percentage of qualifications. A weighted-means analysis was used because there was no even distribution by sex in the sample and the trainee population at large. Accordingly, this analysis is appropriate

Table 2

Night Rifle Marksmanship Performance

Performance dimensions	Type of attenuation								
	Optical density of LAD (n = 985)			Moonlight without target lights (n = 281)			Moonlight with lights (n = 290)		
	5.3	5.0	4.5	New	Qtr	Full	New	Qtr	Full
Qualifications	36%	52%	57%	33%	60%	52%	65%	60%	53%
Hits at 25 m	5.5	6.4	6.4	5.6	7.0	6.9	6.3	6.6	6.7
Hits at 50 m	2.8	3.7	3.9	2.6	4.0	3.4	4.3	4.3	4.4
Total hits	8.3	10.1	10.4	8.2	11.0	10.3	10.6	10.9	11.1
Rounds fired	44.1	41.7	41.2	48.5	45.1	47.3	40.4	40.0	42.7

only for assessing the effects of a trainee's sex on the likelihood of qualifying for record. The results indicated that the only significant main effect due to the sex of the trainee was on qualification scores ($F(1, 1{,}538) = 36.50$, $p < .001$); females were less likely to qualify than were males (36% vs. 55%). No remaining effect involving the sex of a trainee approached significance ($p > .05$ in all cases). Since no interactive effects involved this factor, scores were collapsed across sex in all subsequent analyses.

Simulated vs. Actual Night Illumination. A 2 x 3 unweighted-means was performed that included two types of attenuation (LADs and actual night without target lights) and three levels of illumination. The night condition with target lights was omitted so that more direct comparisons could be made between simulated and actual illumination levels.

The results, shown in Table 3, indicated only a significant main effect due to illumination level on qualifications. Subsequent Newman-Keuls analyses revealed that qualifications obtained in the full and quarter moon phases did not differ from each other ($p > .05$) but were significantly higher than those evidenced during the new moon phase ($p < .05$ in both cases). The absence of either a main or interactive effect due to the type of attenuation factor strongly supports the idea that performances with LADs correspond to performances obtained at night.

Table 3

Analysis of Variance of Qualification Scores

Source	df	MS	F
Type of attenuation (A)	1	.00	.00
Level of illumination (B)	2	4.11	17.02***
A x B	2	.36	1.47
Error	1260	.24	

***$p < .001$

Moonlight With Target Lights. A separate analysis was performed on qualifications evidenced when target lights were used at night. The results of a one-way unweighted-means analysis of variance indicated that the effects of illumination level did not reach significance ($F(2, 287) = 1.29$, $p > .05$). Apparently the flashing target lights eliminated the performance degradation characteristic of the new moon phase.

Number of Rounds Fired

Sex of Trainee. A 2 x 3 x 3 weighted-means analysis of variance was performed to assess the effects due to the sex of the trainee on the amount of ammunition used. Since none of the effects involving this variable approached significance ($p > .05$ in all cases), scores across the sex variable were combined in all subsequent analyses.

Simulated vs. Actual Night Illumination. The results of a 2 x 3 unweighted-means analysis of variance indicated significant main effects on the number of rounds fired due to the type of attenuation ($F(1, 1,260) = 45.17$, $p < .001$) and to the level of illumination ($F(2, 1,260) = 6.15$, $p < .01$). Specifically, the mean rounds fired were fewer with the LADs (42.34) than during actual night (46.97) across all illumination levels. Also, more rounds were fired during the new moon phase (45.04) than during the quarter moon (42.52) and full moon (42.49) phases.

Moonlight With Target Lights. The main effect of illumination level on the number of rounds fired was significant ($F(2, 287) = 3.47$, $p < .05$) according to a one-way unweighted-means analysis. Newman-Keuls analyses indicated that significantly fewer rounds ($p < .05$ in all cases) were fired during the full moon phase than during either the quarter or new moon phases, which did not differ from each other ($p > .05$).

DISCUSSION

Along most of the performance indexes, male trainees scored significantly higher than did females. This sex difference was evident across the various illumination levels (both simulated and actual). Perhaps because of their shorter arms, women experienced more difficulty than men in aligning a rifle on target. That is, when trying to maintain a line of sight while firing, women could not rest their heads as comfortably on top of the rifle stock as men could. To accommodate sex differences in physical stature, shorter rifle stocks, new sighting systems, or different night-fire procedures need to be developed.

As expected, the level of illumination affected marksmanship performance during both simulated and actual moonlight conditions (without target lights). In particular, fewer qualifications were evidenced during the new moon, as compared to the quarter and full moon phases, which did not differ.

In accordance with existing literature (e.g., Van Cott & Kinkade, 1972, p. 49), these findings suggest that predominantly photopic (cone) vision was involved during the full moon (4.5) and quarter moon (5.0) phases. However, the sharp degradation evidenced in the new moon phase suggests that predominantly scotopic vision was used at this level. Target lights at night, however, eliminated differences across the various

moon phases. Apparently the use of flashing lights that silhouette the target for 1 second eliminates the performance decline resulting from the reduced illumination of the new moon phase.

The major finding of this research was that performances obtained with the 5.3-, 5.0-, and 4.5-density LADs closely approximated performances during the new, quarter, and full moon phases, respectively. Results validated the behavioral correspondence between the various optical density LADs and actual moonlight in the specific training environment of the Fort Jackson night-fire range. The results suggest that the LADs may be used as an effective adjunct to, or as a substitute for, training at night. As such, LADs provide the user with a great deal of control over the immediate training situation and eliminate the handicap of firing during the new moon, when the likelihood of qualifying for record is substantially lower.

Using the LADs during daylight affords at least two major advantages over actual night training with regard to savings in both ammunition and time. Specifically, LAD wearers used an average of 4.6 fewer rounds of ammunition than did trainees who fired during actual night. Since about 50,000 recruits undergo BT each year at Fort Jackson, this saves roughly 231,500 rounds (estimated cost, $18,520) for the testing phase alone. This figure does not include the potential savings derived from practice sessions and refires (i.e., failures to qualify that require the trainee to fire again for record).

The use of LADs can save time as well as ammunition expenditures. Six hours is allotted for the instruction, practice, and testing of night rifle marksmanship skills. Before the night session, however, an average of 3 additional hours usually is spent waiting for suitable levels of darkness to fall. This "dead" time can be reduced if trainees fire for record with the LADs immediately after receiving instruction and practice. The saving is estimated to be about 178,000 workhours per year (Bleda & Labrozzi, 1979), including both the training company personnel and the cadre responsible for operating the night-fire range. Use of LADs translates into a financial savings of about $500,000 a year.

There are other advantages to using simulated rather than actual levels of darkness. Specifically, many safety problems in night training would be alleviated by the LADs, because individual and group performances would be monitored by observers with full vision. Moreover, LADs training allows instructors to make more accurate observations, evaluations, and corrective feedback of trainee performance than they could at night; this increased precision could improve training effectiveness. Finally, LADs provide administrative flexibility so that trainees and cadre do not have to perform late at night.

The potential military applications of the LADs are much broader than the specific rifle marksmanship example. In particular, the increased range, lethality, and accuracy of modern weapons systems has led to tactics and doctrine that emphasize the concept of continuous operations. The continuous operations concept requires that combat and

support functions be conducted around the clock and under all illumination levels to reduce the effectiveness of modern weapons in the hands of the enemy. Accordingly, combat personnel must be trained to rely on reduced visual cues to perform continuous operations successfully. The LADs provide a safe, convenient, and effective means to achieve this objective.

REFERENCES

Bleda, P. R., & Johnson, T. M. Goggles That Turn Off the Sun. Army, March 1978, 28, 36-39.

Bleda, P. R., & Labrozzi, A. In the Dark of the Day. Infantry, March-April 1979, 69(2), 32-34.

Farrell, J. P. Simulating Night Visual Conditions During the Day With Light Attenuating Devices. Behavior Research Methods and Instrumentation, 1975, 7, 539-541.

Peters, J. I., Bleda, P. R., & Fineberg, M. L. Effects of Illumination Level and Sense of Direction on Land Navigation Performance. ARI Technical Paper 362, May 1979.

Van Cott, H. P., & Kinkade, R. G. Human Engineering Guide to Equipment Design. New York: McGraw-Hill Inc., 1972.

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1 HQUSACDEC, Ft Ord, ATTN: ATEC-EX-E-Hum Factors
2 USAEEC, Ft Benjamin Harrison, ATTN: Library
1 USAPACDC, Ft Benjamin Harrison, ATTN: ATCP-HR
1 USA Comm-Elect Sch, Ft Monmouth, ATTN: ATSN-EA
1 USAEC, Ft Monmouth, ATTN: AMSEL-CT-HDP
1 USAEC, Ft Monmouth, ATTN: AMSEL-PA-P
1 USAEC, Ft Monmouth, ATTN: AMSEL-SI-CB
1 USAEC, Ft Monmouth, ATTN: C, Facl Dev Br
1 USA Materials Sys Anal Agcy, Aberdeen, ATTN: AMXSY-P
1 Edgewood Arsenal, Aberdeen, ATTN: SAREA-BL-H
1 USA Ord Ctr & Sch, Aberdeen, ATTN: ATSL-TEM-C
2 USA Hum Engr Lab, Aberdeen, ATTN: Library/Dir
1 USA Combat Arms Trng Bd, Ft Benning, ATTN: Ad Supervisor
1 USA Infantry Hum Rsch Unit, Ft Benning, ATTN: Chief
1 USA Infantry Bd, Ft Benning, ATTN: STEBC-TE-T
1 USASMA, Ft Bliss, ATTN: ATSS-LRC
1 USA Air Def Sch, Ft Bliss, ATTN: ATSA-CTD-ME
1 USA Air Def Sch, Ft Bliss, ATTN: Tech Lib
1 USA Air Def Bd, Ft Bliss, ATTN: FILES
1 USA Air Def Bd, Ft Bliss, ATTN: STEBD-PO
1 USA Cmd & General Stf College, Ft Leavenworth, ATTN: Lib
1 USA Cmd & General Stf College, Ft Leavenworth, ATTN: ATSW-SE-L
1 USA Cmd & General Stf College, Ft Leavenworth, ATTN: Ed Advisor
1 USA Combined Arms Cmbt Dev Act, Ft Leavenworth, ATTN: DepCdr
1 USA Combined Arms Cmbt Dev Act, Ft Leavenworth, ATTN: CCS
1 USA Combined Arms Cmbt Dev Act, Ft Leavenworth, ATTN: ATCASA
1 USA Combined Arms Cmbt Dev Act, Ft Leavenworth, ATTN: ATCACO-E
1 USA Combined Arms Cmbt Dev Act, Ft Leavenworth, ATTN: ATCACC-CI
1 USAECOM, Night Vision Lab, Ft Belvoir, ATTN: AMSEL-NV-SD
3 USA Computer Sys Cmd, Ft Belvoir, ATTN: Tech Library
1 USAMERDC, Ft Belvoir, ATTN: STSFB-DQ
1 USA Eng Sch, Ft Belvoir, ATTN: Library
1 USA Topographic Lab, Ft Belvoir, ATTN: ETL-TD-S
1 USA Topographic Lab, Ft Belvoir, ATTN: STINFO Center
1 USA Topographic Lab, Ft Belvoir, ATTN: ETL-GSL
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: CTD-MS
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: ATS-CTD-MS
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: ATSI-TE
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: ATSI-TEX-GS
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: ATSI-CTS-OR
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: ATSI-CTD-DT
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: ATSI-CTD-CS
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: DAS/SRD
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: ATSI-TEM
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: Library
1 CDR, HQ Ft Huachuca, ATTN: Tech Ref Div
2 CDR, USA Electronic Prvg Grd, ATTN: STEEP-MT-S
1 HQ, TCATA, ATTN: Tech Library
1 HQ, TCATA, ATTN: AT CAT-OP-Q, Ft Hood
1 USA Recruiting Cmd, Ft Sheridan, ATTN: USARCPM-P
1 Senior Army Adv., USAFAGOD/TAC, Elgin AF Aux Fld No. 9
1 HQ, USARPAC, DCSPER, APO SF 96558, ATTN: GPPE-SE
1 Stimson Lib, Academy of Health Sciences, Ft Sam Houston
1 Marine Corps Inst., ATTN: Dean-MCI
1 HQ, USMC, Commandant, ATTN: Code MTMT
1 HQ, USMC, Commandant, ATTN: Code MPI-20-28
2 USCG Academy, New London, ATTN: Admission
2 USCG Academy, New London, ATTN: Library
1 USCG Training Ctr, NY, ATTN: CO
1 USCG Training Ctr, NY, ATTN: Educ Svc Ofc
1 USCG, Psychol Res Br, DC, ATTN: GP 1/62
1 HQ Mid-Range Br, MC Det, Quantico, ATTN: P&S Div

1 US Marine Corps Liaison Ofc, AMC, Alexandria, ATTN: AMCGS-F
1 USATRADOC, Ft Monroe, ATTN: ATRO-ED
6 USATRADOC, Ft Monroe, ATTN: ATPR-AD
1 USATRADOC, Ft Monroe, ATTN: ATTS-EA
1 USA Forces Cmd, Ft McPherson, ATTN: Library
2 USA Aviation Test Bd, Ft Rucker, ATTN: STEBG-PO
1 USA Agcy for Aviation Safety, Ft Rucker, ATTN: Library
1 USA Agcy for Aviation Safety, Ft Rucker, ATTN: Educ Advisor
1 USA Aviation Sch, Ft Rucker, ATTN: PO Drawer O
1 HQUSA Aviation Sys Cmd, St Louis, ATTN: AMSAV-ZDR
2 USA Aviation Sys Test Act., Edwards AFB, ATTN: SAVTE-T
1 USA Air Def Sch, Ft Bliss, ATTN: ATSA-TEM
1 USA Air Mobility Rsch & Dev Lab, Moffett Fld, ATTN: SAVDL-AS
1 USA Aviation Sch, Res Trng Mgt, Ft Rucker, ATTN: ATST-T-RTM
1 USA Aviation Sch, CO, Ft Rucker, ATTN: ATST-D-A
1 HQ, DARCOM, Alexandria, ATTN: AMXCD-TL
1 HQ, DARCOM, Alexandria, ATTN: CDR
1 US Military Academy, West Point, ATTN: Serials Unit
1 US Military Academy, West Point, ATTN: Ofc of Milt Ldrship
1 US Military Academy, West Point, ATTN: MAOR
1 USA Standardization Gp, UK, FPO NY, ATTN: MASE-GC
1 Ofc of Naval Rsch, Arlington, ATTN: Code 452
3 Ofc of Naval Rsch, Arlington, ATTN: Code 458
1 Ofc of Naval Rsch, Arlington, ATTN: Code 450
1 Ofc of Naval Rsch, Arlington, ATTN: Code 441
1 Naval Aerospc Med Res Lab, Pensacola, ATTN: Acous Sch Div
1 Naval Aerospc Med Res Lab, Pensacola, ATTN: Code L51
1 Naval Aerospc Med Res Lab, Pensacola, ATTN: Code L5
1 Chief of NavPers, ATTN: Pers-OR
1 NAVAIRSTA, Norfolk, ATTN: Safety Ctr
1 Nav Oceanographic, DC, ATTN: Code 6251, Charts & Tech
1 Center of Naval Anal, ATTN: Doc Ctr
1 NavAirSysCom, ATTN: AIR-5313C
1 Nav BuMed, ATTN: 713
1 NavHelicopterSubSqua 2, FPO SF 96601
1 AFHRL (FT) Williams AFB
1 AFHRL (TT) Lowry AFB
1 AFHRL (AS) WPAFB, OH
2 AFHRL (DOJZ) Brooks AFB
1 AFHRL (DOJN) Lackland AFB
1 HQUSAF (INYSD)
1 HQUSAF (DPXXA)
1 AFVTG (RD) Randolph AFB
3 AMRL (HE) WPAFB, OH
2 AF Inst of Tech, WPAFB, OH, ATTN: ENE/SL
1 ATC (XPTD) Randolph AFB
1 USAF AeroMed Lib, Brooks AFB (SUL-4), ATTN: DOC SEC
1 AFOSR (NL), Arlington
1 AF Log Cmd, McClellan AFB, ATTN: ALC/DPCRB
1 Air Force Academy, CO, ATTN: Dept of Bel Scn
5 NavPers & Dev Ctr, San Diego
2 Navy Med Neuropsychiatric Rsch Unit, San Diego
1 Nav Electronic Lab, San Diego, ATTN: Res Lab
1 Nav TrngCen, San Diego, ATTN: Code 9000-Lib
1 NavPostGraSch, Monterey, ATTN: Code 55Aa
1 NavPostGraSch, Monterey, ATTN: Code 2124
1 NavTrngEquipCtr, Orlando, ATTN: Tech Lib
1 US Dept of Labor, DC, ATTN: Manpower Admin
1 US Dept of Justice, DC, ATTN: Drug Enforce Admin
1 Nat Bur of Standards, DC, ATTN: Computer Info Section
1 Nat Clearing House for MH-Info, Rockville
1 Denver Federal Ctr, Lakewood, ATTN: BLM
12 Defense Documentation Center
4 Dir Psych, Army Hq, Russell Ofcs, Canberra
1 Scientific Advsr, Mil Bd, Army Hq, Russell Ofcs, Canberra
1 Mil and Air Attache, Austrian Embassy
1 Centre de Recherche Des Facteurs, Humaine de la Defense Nationale, Brussels
2 Canadian Joint Staff Washington
1 C/Air Staff, Royal Canadian AF, ATTN: Pers Std Anal Br
3 Chief, Canadian Def Rsch Staff, ATTN: C/CRDS(W)
4 British Def Staff, British Embassy, Washington
1 Def & Civil Inst of Enviro Medicine, Canada
1 AIR CRESS, Kensington, ATTN: Info Sys Br
1 Militaerpsykologisk Tjeneste, Copenhagen
1 Military Attache, French Embassy, ATTN: Doc Sec
1 Medecin Chef, C.E.R.P.A.-Arsenal, Toulon/Naval France
1 Prin Scientific Off, Appl Hum Engr Rsch Div, Ministry of Defense, New Delhi
1 Pers Rsch Ofc Library, AKA, Israel Defense Forces
1 Ministeris van Defensie, DOOP/KL Afd Sociaal Psychologische Zaken, The Hague, Netherlands